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JIN F. NG
PRIMARY EXAMINER
GROUP 263

(12) UK Patent Application (19) GB (11) 2 121 649 A

(21) Application No 8306293
(22) Date of filing
8 Mar 1983
(30) Priority data
(31) 8212777
8303988
(32) 4 May 1982
14 Feb 1983
(33) United Kingdom (GB)
(43) Application published
21 Dec 1983
(51) INT CL³ H04B 5/00
(52) Domestic classification
H4L X
U1S 1943 2100 H4L
(56) Documents cited
GB A 2043400
GB A 2052414
GB 1489432
GB 1412385
GB 1379801
(58) Field of search
H4L
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(54) Cordless transmission in audio reproduction system

(57) A cordless transmission system, such as a cordless headphone system, comprises a frequency modulation radio transmitter 4 connected to the output of a domestic sound reproducing apparatus 1, such as a high fidelity system or television set. A pair of headphones 3 is connected to the output of a portable frequency modulation receiver 7. The transmitter 4 and receiver 7 may be made very compact and the receiver 7 is carried by a listener, thus obviating the need for a wired connection between the headphones 3 and the amplifier 1. Use of the frequency modulation technique permits very high sound quality for the listener.

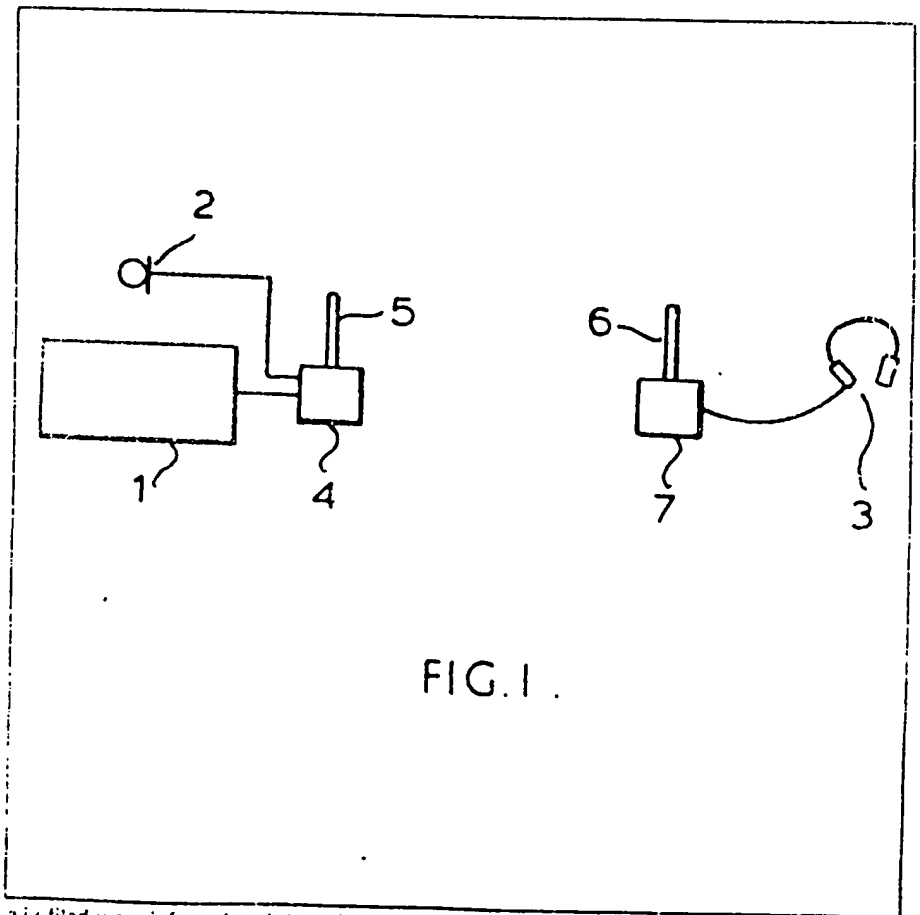

FIG.1.

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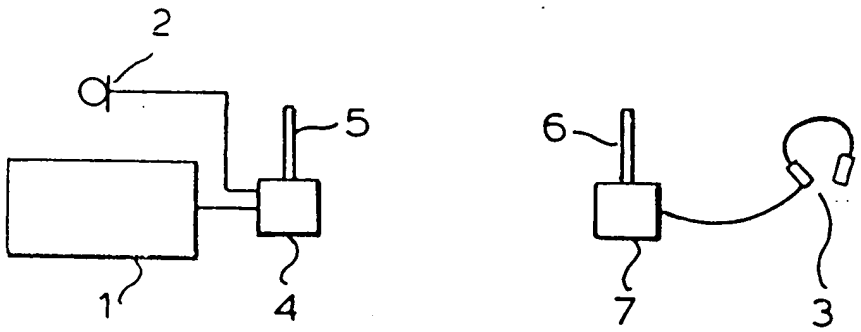

FIG.1

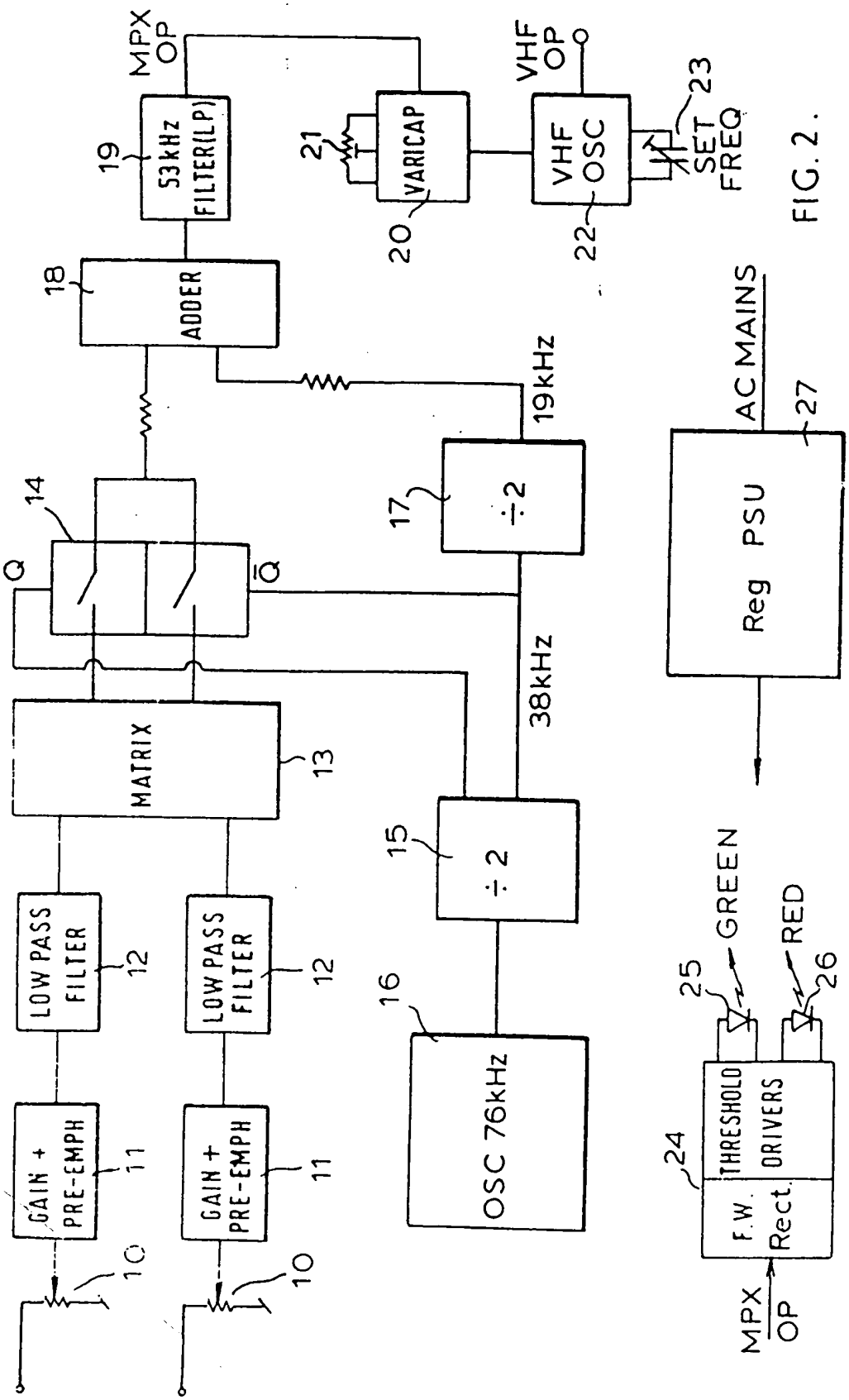
MPX OP
19
53kHz FILTER(LP)
18
ADDER
21
VARICAP
20
VHF OP
VHF OSC
22
23
SET FREQ
19kHz
17
÷2
14
Q
Q̄
38kHz
MATRIX
13
15
÷2
16
OSC 76kHz
LOW PASS FILTER
12
LOW PASS FILTER
12
GAIN + PRE-EMPH
11
GAIN + PRE-EMPH
11
10
10
AC MAINS
27
Reg PSU
GREEN
RED
25
26
24
THRESHOLD
DRIVERS
F.W. Rect.
MPX OP

FIG. 2.

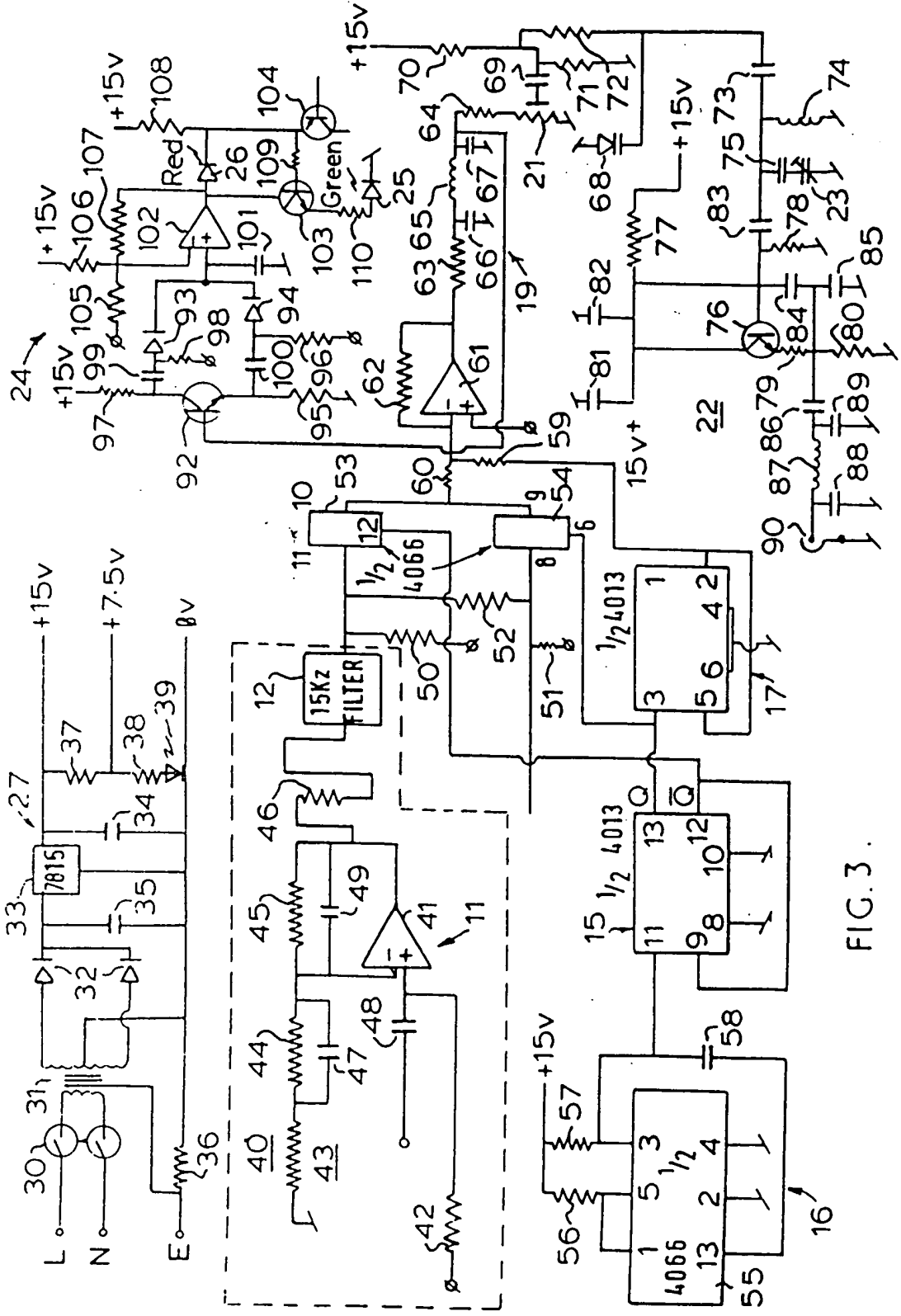
+15v
+7.5v
0v
15v+
L
N
E
Red
Green
15Kz FILTER
7815
4066
1/2 4013
Q
$\overline{Q}$

FIG. 3.

SPECIFICATION

Improvements in or relating to cordless transmission systems

The present invention relates to cordless systems, such as headphone systems. Such systems may be used to permit free movement, for instance, of personnel wearing headphones by avoiding the usual flexible cable connection to amplifiers and the like for driving the headphones.

According to the invention, there is provided a cordless transmission system, comrising a frequency modulation transmitter connected to an output of an apparatus for producing an electrical signal representing sound, and an electro-acoustic transducer connected to an output of a frequency modulation receiver.

Preferably, the apparatus is a domestic sound reproducing apparatus, the receiver is a portable receiver, and the electro-acoustic transducer is a headphone.

One application of such a system is to high fidelity, in which the sound reproducing apparatus comprises a high fidelity amplifier for reproduction from disc, tape, or conventional FM radio. Connection may also be made, via the high fidelity system or separately, to a television receiver. The absence of a physical connection between the headphones and the sound reproducing apparatus permits a listener to move about the service area of the transmitter freely and removes the restriction created by the usual predetermined length of connecting cable. This can assist in improving the comfort of the listener.

The transmitter may also be connected to a microphone. For instance, with the microphone placed in the room where listening via headphones is taking place, it becomes possible for several listeners to talk to each other in a normal manner while wearing the headphones and to hear a telephone ringing or a door-bell without hindrance.

The portable receiver may be essentially of the conventional FM tuner type provided with a headphone amplifier, which can be compact as it is merely required to produce a signal level sufficient to drive the headphones. Such receivers can be made very compact and can be battery powered while providing a very good performance in terms of noise, distortion, and frequency response.

An advantageous embodiment of the transmitter is defined in the appended subclaims 6 to 10. An advantage of this type of transmitter is that it is relatively simple, may be made very compact, and is also capable of good performance. It is possible to include the transmitter in the high fidelity amplifier or other sound reproducing equipment, thus making the system even more compact by eliminating the need for a separate housing and interconnection.

The invention will be further described, by way of example with reference to the accompanying drawings, in which:

Figure 1 is a block diagram of a cordless headphone system constituting a preferred embodiment of the invention;

Figure 2 is a block diagram of a transmitter of the system of Fig. 1; and

Figure 3 is a circuit diagram of the transmitter of Fig. 2.

The system shown in Fig. 1 comprises a sound reproducing apparatus 1, for instance a domestic high fidelity system. The output of the apparatus 1 is connected to a first input of an FM transmitter 4, whose second input is connected to a microphone 2. The transmitter 4 has an aerial 5.

A pair of headphones 3 for providing personal listening is connectedto the output of an FM radio 7 provided with an aerial 6. The apparatus 1, the headphones 3, the transmitter 4, and the receiver 7 are arranged to provide stereo communication so that the listener receives a stereo signal via the headphones 3. The microphone 2 is disposed in the room where personal listening is to take place and may be a stereo microphone, or may be a single microphone whose output is arranged to feed a monophonic signal to the transmitter 4. The microphone 2 thus allows the listener to hear sounds in the room while listening to the output of the apparatus 1. Thus, ordinary conversation may continue and the listener may hear other sounds, such as telephone ringing and a door-bell.

The receiver 7 is battery-powered and is sufficiently compact to be worn unobtrusively by the listener. Thus, the listener can move about freely in the listening environment and can adopt any position within the service area of the transmitter 4. In order to avoid interference, the output power of the transmitter 4 may be made relatively low, for instance sufficient to cover a household.

Fig. 2 shows the transmitter 4 in greater detail. The transmitter has two audio input channels, each comprising a level-setting attenuator 10, a gain and pre-emphasis stage 11, and a low pass filter 12. The outputs of the low pass filters 12 are supplied to a matrix 13 which mixes a proportion of the output signal from each low pass filter with the output signal from the other low pass filter. The outputs of the matrix 13 are connected to respective inputs of a pair of electronic switches 14, which are controlled in anti-phase by the Q and $\bar{Q}$ outputs of a divide-by-2 flip-flop 15. The flip-flop 15 is driven by a 76 KHz oscillator 16.

One output of the flip-flop 15 is connected to the input of a further devide-by-2 flip-flop 17 whose output is mixed with the output from the switches 14 in an adding circuit 18. The output of the circuit 18 is passed via a

53 KHz low pass filter 19 to a Varicap circuit 20 provided with a deviation-adjusting potentiometer 21. The Varicap circuit 20 forms part of the tuned circuit of a VHF oscillator 22 having a frequency setting adjustable capacitor 23. The VHF output from the oscillator 22 is supplied to the aerial (not shown).

The output MPX OP of the filter 19 is further supplied to the input of a combined full wave rectifier and threshold drivers 24. The threshold drivers drive a green light emitting diode 25 and a red light emitting diode 26. A regulated power supply 27 is provided for powering the transmitter from the AC Mains.

Fig. 3 is a detailed circuit diagram of the transmitter 4. The power supply 27 comprises a double-pole ON/OFF switch 30, a mains isolating transformer 31, rectifier diodes 32, a voltage regulator 33 of the 7815-type, smoothing and stabilizing capacitors 34 and 35, resistors 36, 37, and 38, and a power-indicating light emitting diode 39.

In Fig. 3, only one of the two input channels is shown at 40 the other channel being identical. The gain and pre-emphasis stage 11 comprises an operational amplifier 41, resistors 42 to 46, and capacitors 47 to 49. This stage provides sufficient gain to overcome losses in the other parts of the circuit and to provide sufficient level for modulating the oscillator 22. The stage also supplies the conventional pre-emphasis, equivalent to a time constant of 50 microseconds as in conventional VHF-FM techniques. The filter 12 is a low pass filter having a cut off frequency of 15 KHz, and its output, together with the output of the corresponding filter in the other channel, is supplied to the matrix comprising resistors 50 to 52. The outputs of the matrix are supplied to respective electronic switches 53 and 54 which are bilateral CMOS switches forming half of a 4066-type CMOS integrated circuit.

The other two switches 55 of this integrated circuit form, together with resistors 56 and 57 and capacitor 58, a multivibrator whose frequency of operation is 76 KHz. The output of the oscillator is divided by two in the flip-flop 15, comprising half of a 4013-type CMOS integrated circuit whose Q and $\bar{Q}$ outputs are connected to the control inputs of the switches 53 and 54. The Q output of the Flip-flop 15 is connected to the input of the flip-flop 17 forming the other half of the integrated circuit whose output is connected to a resistor 58. The switches 53 and 54 thus operate in antiphase and alternately pass the outputs of the two input channels with a repetition rate of 38 KHz. The divider 17 provides a pilot tone signal at 19 KHz whose level relative to the level of the multiplexed audio signal is set by the ratio of the resistor 59 to a resister 60 which together with an operational amplifier 61 and a resistor 62, constitute the mixing circuit 18 while resistors 63 and 64, inductor 65, and capacitors 66 and 67 form the 53 KHz low pass filter 19.

The varicap circuit 20 comprises a varicap diode 68, a capacitor 59 and resistors 70 to 72. The diode 68 is connected via a capacitor 73 across an inductor 74 which, together with the capacitor 23 and a further capacitor 75, forms the tuned circuit of the VHF oscillator 22. The oscillator 22 further comprises a transistor 76, resistors 77 to 80, and capacitors 81 to 86. The output of the oscillator is supplied via a low-pass filter comprising an inductor 87 and capacitors 88 and 89 for harmonic suppression to the aerial via output terminal 90. The VHF oscillator 22 is adjusted to a frequency in the VHF band, for instance approximately 104 MHz.

The output of the filter 19 is connected to the base of a transistor 92 which, together with diodes 93 and 94, resistors 95 to 98, and capacitors 99 and 100, forms the full wave rectifier of the circuit 24. The full wave rectifier, together with capacitor 101, forms a peak envelope detector for the multiplexed signal from the filter 19.

The threshold drivers comprises an operational amplifier 102, transistors 103 and 104, and resistors 105 to 110. The sensitivity of the threshold drivers is such that the green ligh emitting diode 25 is illuminated when the envelope peak of the multiplexed signal is in the region of full modulation, corresponding to a maximum deviation of 75 KHz in the FM signal at the output of the transmitter 22, whereas the red light emitting diode 26 is illuminated when this level is exceeded, corresponding to overmodulation. Thus, the attenuators 10 and/or the volume control of the high fidelity amplifier or other sound reproducing apparatus may be adjusted while monitoring the peak modulation level so as to ensure that the oscillator 22 is fully modulated to optimize dynamic range while avoiding overmodulation.

Although a system has been described in which signals from the output of a high fidelity sound system are transmitted cordlessly to a pair of headphones, many other applications are possible, For instance, loudspeakers may be used in place of the headphones to provide a cordless link to the remainder of a high fidelity system. A separate receiver may be provided for each of a stereo pair of loudspeakers, and a power amplifier would generally have to be provideo between the or each speaker and the receiver to which it is connected.

Use with a television set has already been mentioned, and the system can also be used with a video cassette recorder or disc player. The system may also be provided in a vehicle to provide a cordless link between a mobile radio or cassette player and the listener.

The system may also be used in an alarm

system to provide remote audible indication of an alarm, for instance in an intruder alarm for a building or a vehicle. The system may further be used as part of a paging system, for instance acting as a repeater of a paging device or "bleeper".

The system may further be used as part of a data transfer system, for instance for transferring computer data.

CLAIMS

1. A cordless transmission system, comprising a frequency modulation transmitter connected to an output of an apparatus for producing an electrical signal representing sound, and an electro-acoustic transducer connected to an output of a frequency modulation receiver.

2. A system as claimed in claim 1, in which the apparatus is a domestic sound reproducing apparatus, the receiver is a portable receiver, and the electro-acoustic transducer is a headphone.

3. A system as claimed in claim 2, in which the transmitter is also connected to a microphone.

4. A system as claimed in claim 2 or 3, in which the transmitter, the sound reproducing apparatus, the headphone and the receiver have two information channels for transmitting stereo signals.

5. A system as claimed in claim 4, in which the sound reproducing apparatus includes a high fidelity amplifier and the transmitter is built into the amplifier.

6. A system as claimed in claim 4 or 5, in which the transmitter includes a stereo multiplexer comprising a matrix for mixing a portion of the signal from each incoming audio channel with the signal of the other channel, an electronic switch for alternately sampling the output signals of the matrix, and a supersonic oscillator for controlling the electronic switch.

7. A system as claimed in claim 6, in which the electronic switch comprises a pair of bilateral CMOS switches.

8. A system as claimed in claim 6 or 7, in which the multiplexer includes a divider for dividing by two the output of the oscillator and a mixer for mixing the outputs of the divider and electronic switch.

9. A system as claimed in claim 8, in which the transmitter includes a monitoring circuit connected to the output of the multiplexer for providing a visual indication of the peak modulation level.

10. A system as claimed in claim 9, in a which the monitoring circuit includes a first light emitting diode arranged to be illuminated when the modulation level is substantially equal to a maximum acceptable level and a second light emitting diode arranged to be illuminated when the modulation level exceeds the maximum acceptable level.

11. A cordless transmission system substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

Printed for Her Majesty's Stationery Office
by Burgess & Son (Abingdon) Ltd.—1983.
Published at The Patent Office, 25 Southampton Buildings,
London, WC2A 1AY, from which copies may be obtained.